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Opinion Article

Identification of Disease Causing Micro-organisms Using Biosensors

Scott Rowe*

Department of Medicine, University Paris-Sud, Orsay, France

ABOUT THE STUDY

To ensure the safety of food supply and effectively identify viral and bacterial diseases, reliable methods for rapid, selective detection of pathogens are essential. Single-cell detection would be ideal for certain matrices particularly in clinical diagnostics because even a low concentration of bacteria suggests disease. The requirement for more flexible, dependable, and sensitive pathogen targeting has sparked interest in Nanoparticles (NPs) and their inclusion into biosensor systems. NPs having specific optical, electrochemical or magnetic properties may improve the diagnostic procedures' speed and detectability. Furthermore, because they may be used in a variety of combinations we might imagine them being used as point-of-care systems or multiplexed devices. The majority of microorganisms perform a crucial function in nature. Some can pollute food and water as well as cause a variety of infectious diseases in both animals and people.

Traditional approaches for detecting microbial contamination have depended on time-consuming enrichment stages followed by biochemical identification which can take up to a week in some situations. Biological sensors for the detection of microorganisms have been the focus of much study over the last decade, enabling for quick and "real-time" identification. Surface Plasmon Resonance (SPR), amperometric, potentiometric and acoustic wave sensors, as well as their applications for pathogen detection in food and water are the most often utilised biosensor systems based on their transducer qualities. It also emphasises some of the drawbacks of using biosensors for pathogen detection such as sensitivity, cost and the requirement for sample pre-treatment.

Contamination with pathogenic bacteria can result in a variety of issues including diseases in humans and animals as well as pollution in the environment. The management of harmful bacteria outbreaks requires early detection and prevention. Traditional detection methods including cell culture and Polymerase Chain Reaction (PCR) are time-consuming, labor-intensive, insensitive and inconvenient.

As a result, simple and effective harmful bacteria detection approaches incorporating DNAzymes signalling mechanisms such as fluorescence and colour detection have been reported. The molecular recognition element (RNA-cleaving DNAzyme) and the reporter element (peroxidase mimicking DNAzyme) are two types of DNAzymes that have been found to be compatible with isothermal amplification technique for harmful bacteria detection.

Pathogenic bacteria are the cause of a variety of infectious diseases that are getting more serious around the world. The early and precise detection of various pathogenic microorganisms is critical for the successful treatment of pathogenic infection in all areas of health and safety. Optical biosensors are a type of sensor system that allows for easy-to-use, fast, portable, multiplexed and cost-effective diagnostics. The technological and methodological aspect of several optical-sensing techniques platforms and methods for detecting pathogenic microorganisms are reviewed together with the strengths and drawbacks of each technique.

The detection of pathogenic microorganisms is essential for the prevention and detection of health and safety issues. In other industries, such as the food sector, where failure to detect an illness might have disastrous repercussions, legislation is very strict. Despite the pressing requirement for analytical data in the quickest feasible period, classic and typical bacterial detection procedures can take up to 7 or 8 days to provide a response.

This is obviously insufficient, and many academics have recently focused their efforts on developing quick approaches. Fresh technologies, such as biosensors have ushered in new and promising ways. However, much more study and development is required before biosensors can be considered a viable and reliable option. Despite being reliable and frequently used and current bacteria detection technologies are inconvenient and time-consuming, making them unsuitable for field detection. Because of its compactness, portability and minimal reagent consumption, microfluidic lab-on-a-chip technology has become a detective tool for a variety of analytes.

Correspondence to: Dr. Scott Rowe, Department of Medicine, University Paris-Sud, Orsay, France, E-mail: scottrowsuyd@gmx.fr

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Gram staining and direct immunoreaction were used in a unique way, a simple, label-free and sensitive Lateral Flow Strip (LFS) biosensor for foodborne pathogens was developed. In the LFS assay, target bacteria can be immediately marked with Crystal Violet (CV) by one-step staining, which is superior to standard signal marking approaches, and the method's selectivity can be ensured by using a high-specificity monoclonal antibody. This approach can detect 80 CFU mL *S. enteritidis* using *Salmonella enteritidis* (*S. enteritidis*) as a model target.

In optimal conditions, enteritidis can be detected in as little as 11 minutes. Furthermore, using Listeria monocytogenes as a model target, the biosensor demonstrates great universality for both gram-negative and gram-positive bacteria detection. The unexpected application of a biological dye tracer in a strip biosensor demonstrates that the biological dye could be a useful tool for food safety monitoring and early clinical diagnosis as a universal signal tracer for harmful microorganisms.

There are two electrochemical biosensors for detecting the bacteria *Aeromonas hydrophila*. *A. hydrophila* is a new foodborne human pathogen that is frequently identified from a wide range of foods. Because the presence of the aerolysin gene (aerA) is linked to pathogenicity in *A. hydrophila*, a DNA probe corresponding to this gene provides a specific and effective technique for its detection. In the reported biosensors, a DNA probe with the sequence 5′ GTCAAGACGGTGGTGGGCTG was developed and employed as a sensing element. Biosensor had a gold electrode with a Self-Assembled Monolayer (SAM) of mercaptohexanol and thiolated DNA probe as the sensing layer.

A Carbon Paste Electrode (CPE) modified with Multi-Walled Carbon Nanotubes (MWCNTs) comprising covalently attached DNA probe served as the detecting layer in biosensor II. The composition of biosensor detecting layers, the method of probe immobilisation and all parameters impacting hybridization events such as target DNA sample preparation and non-complementary DNA contamination were all thoroughly examined. With both detection layers, several electroactive hybridization indicators were investigated and two were chosen for final determinations.